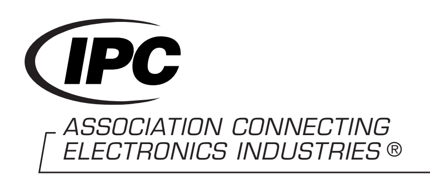


IPC-2584

Sectional Requirements for Implementation of Printed Board Fabrication Data Description



Endorsed by the International Electronics Manuafacturing Initiative (iNEMI)

IPC-2584

May 2007

A standard developed by IPC

3000 Lakeside Drive, Suite 309S, Bannockburn, IL 60015-1249
Tel. 847.615.7100 Fax 847.615.7105
www.ipc.org

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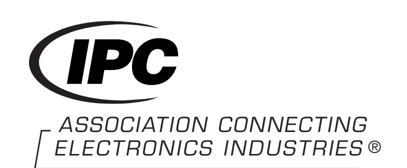
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IPC-2584

Sectional Requirements for Implementation of Printed Board Fabrication Data Description

Developed by the CAD/CAM Convergence Subcommittee (2-17) of the Data Generation and Transfer Committee (2-10) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC
3000 Lakeside Drive, Suite 309S
Bannockburn, Illinois
60015-1249
Tel 847 615.7100
Fax 847 615.7105

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Sectional Requirements for Implementation of Printed Board Fabrication Data Description

INTRODUCTION

This standard is part of the IPC-2580 series of standards. These standards specify a data file format used to describe printed board and printed board assembly products with details sufficient for tooling, manufacturing, assembly, inspection and testing requirements. The format may be used for transmitting information between a printed board designer and a manufacturing or assembly facility. The files are also useful when the manufacturing cycle includes computer-aided processes and numerical control machines.

The IPC-2580 format requirements are provided in a series of standards focused on design printed board fabrication, assembly, inspection, and testing. This standard series consists of a generic standard (IPC-2581) which contains all the general requirements. There are seven sectionals that are focused on the details necessary to accumulate information in a single file that addresses the needs of the manufacturing disciplines producing a particular product.

The sectional standards (IPC-2582 through 2588) paraphrase the important detailed requirements and provide suggested usage and examples for the topic covered by the sectional standard. The information can be used for both manual and for digital interpretations. The data is defined in either English or International System of Units (SI) units.

1 SCOPE

This standard (IPC-2584) provides the information on the manufacturing requirements used for fabricating printed boards. This standard determines the XML schema details, defined in the generic standard (IPC-2581) and some of the 2580 sectional standards that are required to accomplish the focused tasks. When other standards are invoked, their requirements become a mandatory part of the fabrication details as defined in the IPC-2581.

1.1 Intent

The IPC-2581 contains all the requirements necessary to build an electronic product. The cardinality indicated in the IPC-2581 may be superseded by a restriction of an attribute (enumerated string ID) or indication of a requirement that is noted as being optional in the generic standard, however this standard makes the requirement mandatory based on the supply chain communication need.

In order to assist the users of this standard, all the applicable XML schema elements that apply to the Board Fabrication Function are listed in Appendix A. The list is grouped by topics and shows the Absolute Path for the elements that pertain to the focus of this standard. If the Parent element is not present no children are to be considered in the implementation, however all Attributes identified for a particular element **shall** follow the cardinality of the IPC-2581 unless a restriction is stated in this standard.

1.2 Interpretation

"**Shall**", the emphatic form of the verb, is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a **shall** requirement is not permitted, and compliance testing is required in order to demonstrate that the XML instances are correct according to the W3C directives and this standard. The XML schema **shall** be the method to check syntax and semantics. Any appropriate software tool that prompts the user, to correct the ambiguity or to insert missing information, may be used for this purpose.

The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions.

"Will" is used to express a declaration of purpose.

To assist the reader, the word **shall** is presented in bold characters

2 APPLICABLE DOCUMENTS

The following documents contain requirements which, when referenced, constitutes provisions of IPC-2584. At the time of publication, the editions indicated were valid. All documents are subject to revision and parties entering into agreements based on this standard are encouraged to investigate the possibility of applying the most recent additions of the documents indicated below.

The revision of the document in effect at the time of solicitation **shall** take precedence.

IPC-T-50 *Terms and Definitions for Interconnecting and Packaging Electronic Circuits.*

IPC-2581 *Generic Requirements for Printed Board Assembly Products Manufacturing Description Data and Transfer Methodology*

IPC-2582 *Sectional Requirements for Implementation of Administrative Methods for Manufacturing Data Description*

IPC-2583 *Sectional Requirements for Implementation of Drawing Methods for Manufacturing Data Description*

IPC-2588 *Sectional Requirements for Implementation of Part List Product Data Description*

IPC-2589 *Sectional Requirements - Activity Model for Printed Board Assembly Products Manufacturing*

IPC-2614 *Sectional Requirements for Board Fabrication Documentation*

IPC-7351 *Surface Mount Design & Land Patterns*

3 REQUIREMENTS

The requirements of IPC-2581 are a mandatory part of this standard. That document describes the generic requirements for the converged GenCAM and ODB++ formats. The generic details specifically provide data related to design, printed board manufacturing, assembly and test.

The XML schema of the 2581 consists of six major Elements each of which have several children who then become new parent elements. Several of these major elements and their associated new parents are defined in other sectionals thus the requirements of those standards, IPC-2582, IPC-2583, and IPC-2588 are also a mandatory part of the board fabrication standard to the extent of their description and any restrictions contained in this standard.

Each of the standards and the elements defined therein has a specific function or task respectively, and although they may at times be used independently, they become an important addition to the requirements of the board fabrication descriptions. As such the following paragraphs provide the total requirements for the three types of board fabrication files that are supported by the principles of the IPC-2581.

Accordingly, the information interchange for the specific purpose of printed board fabrication is only possible if all the XML instances have been properly prepared for such a purpose.

3.1 Terms and Definitions

The definition of all terms **shall** be in accordance with IPC-T-50 and the following. A term number at the end of a line indicates that it is a reproduction from IPC-T-50 to assist the reader in interpretation of this standard.

3.1.1 Data

Intelligent information that may be used directly by machine in order to accomplish a particular manufacturing event.

3.1.2 Drawings

Hard copy or un-intelligent documentation (e.g. PDF) to which all formatting criteria apply.

3.1.3 Printed Circuit Board

A composite of organic and inorganic material with external and internal wiring allowing electronic components to be mechanically supported and electrically connected. The accepted acronym is **PCB.**

3.1.4 Supplier

The organization or company responsible for providing the goods and/or services required to produce an electronic product which includes physical items as well as intellectual/software characteristics and is documented as either user procurement, supplier data or contractual agreements.

3.1.5 User

The individual, organization, company or agency responsible for the procurement of electrical/electronic hardware, and having the authority to define the class of equipment and any variation or restrictions (i.e., the originator/custodian of the contract detailing these requirements).

3.1.6 Via

An opening in the dielectric layer(s) through which a conductor passes upwards or downwards to subsequent chip or package conductive layers for electrical interconnections or for heat transfer.

3.2 Categories and Content

Table 3-1 provides the major functions that **shall** be addressed by the 2584 standard. The descriptions relate to the appropriate printed board fabrication processes. There are fifteen (15) unique functions that can be defined by the use of the XML elements and the resulting XML instances.

Table 3-1 indicates the relationships of the requirements for various elements and topics within the descriptions for a particular process. The letter **"M"** signifies a *mandatory* requirement. The letter **"O"** signifies an *optional* characteristic that may or may not be pertinent to the particular file or data interchange. A dash signifies an extraneous section (unnecessary). Although software tools used to parse the file will permit the extraneous data, it is recommended that only the requirements identified as mandatory or optional are included in the file in order to reduce file size transfer.

Table 3-1 Function Relationship of a 2580 Fabrication File

Name	Fabrication			Comment and Standard Reference
	1	2	3	
File Content Descriptions	M	M	M	Elements indicated in IPC-2582 according to cardinality of IPC-2581 and restrictions of this standard
Logistic Descriptions	M	M	M	
File History Descriptions	O	M	M	
BOM (Board Fabrication Materials)	M	M	M	Elements indicated in IPC-2588 according to cardinality of IPC-2581 and restrictions of this standard
AVL (Board Material Suppliers)	-	M	M	
Miscellaneous Image Layers	-	O	O	Elements indicated in IPC-2583 according to cardinality of IPC-2581 and restrictions of this standard
Documentation Layers	O	M	M	
Design for eXcellence (Dfx) Analysis	O	O	O	
Component Packages *	-	-	O	Elements indicated in this sectional standard, according to cardinality of IPC-2581 and any restrictions contained in the following paragraphs of this standard *Although Component Packages and Land Patterns are further defined in IPC-2586, and Net Lists are further defined in IPC-2587, their XML schemas are repeated in this standard.
Land Patterns *	-	-	O	
Soldermask, Legend Layers	M	M	M	
Drilling and Routing (Tooling) Layers	M	M	M	
Net List (Soft tooling) *	O	M	M	
Outer Conductive Layers	M	M	M	
Inner Conductive Layers	M	M	M	
Board Construction	M	M	M	

It should be understood that without a Net List it is difficult to verify that the produced board meets the design intent.

The correlation between the various descriptions identified in this standard are indicated in Figure 3-1. This shows the relationship of test coupons, individual board, phototools, etc. The illustration identifies those characteristics that are available in the CAD tools and are usually transferable to the CAM station. The left hand side illustrates combinations of the design intent including assembly characteristics and embedded components. Some of these concepts are important for a 2584 FAB1, FAB2 or FAB3 file and are illustrated for the board manufacturing processes shown on the right hand side of the illustration.

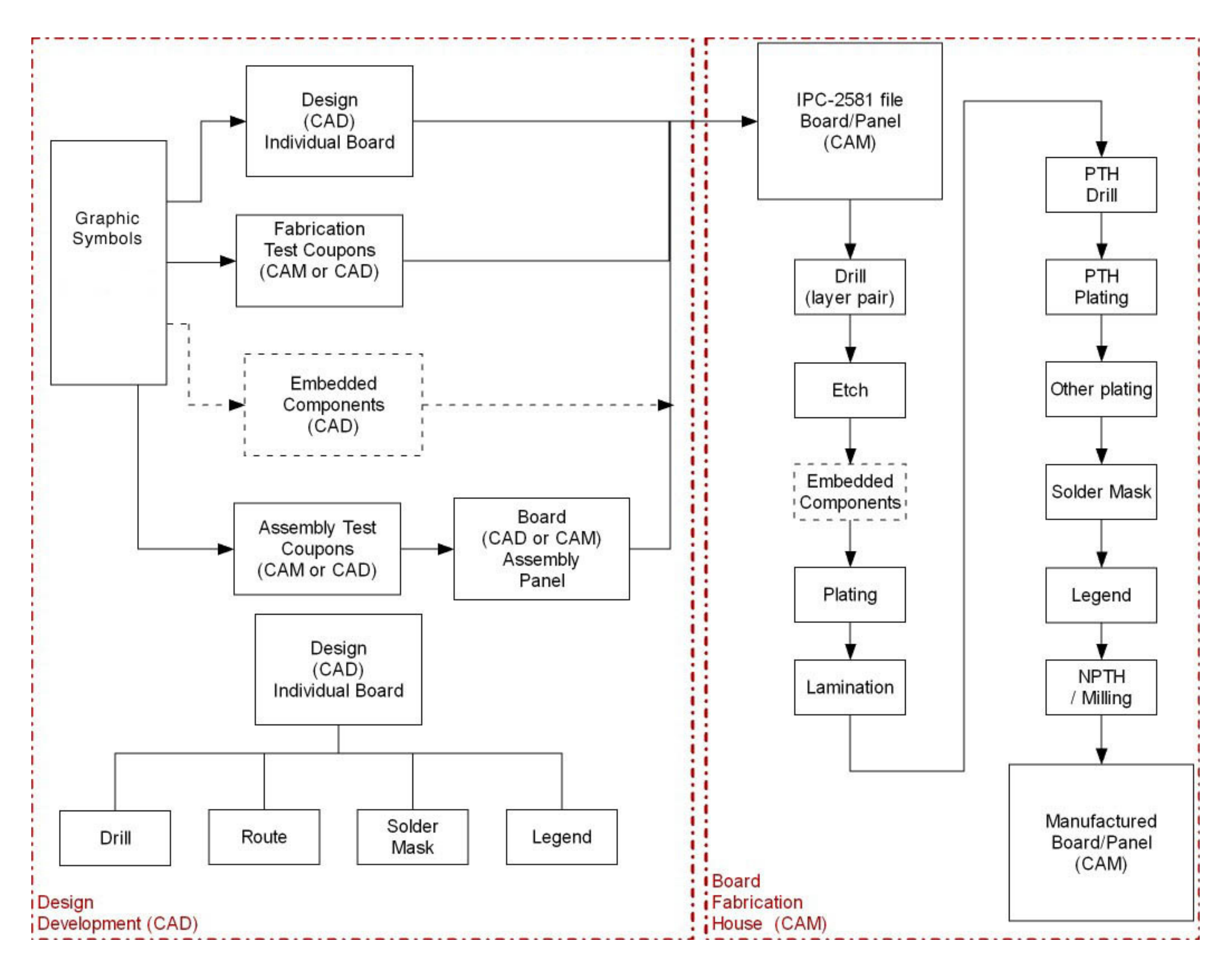


Figure 3-1 Board fabrication data relationship

4 GENERAL RULES

The following details reflect the rules used in describing the printed board characteristics in order to meet the requirements for board fabrication. These rules are intended to meet the needs of the manufacturer to understand the customer requirements. Wherever necessary, additional requirements have been detailed to reflect precision.

The attributes and rules described in IPC-2581 are required. Wherever necessary, detailed descriptions or definitions of the entities, attributes or characteristics are reproduced as defined in 2581 in an attempt to clearly define the mandatory descriptions.

4.1 File Content Descriptions

The File Content Descriptions **shall** be in accordance with IPC-2582. This is a mandatory requirement for all FAB layers, FAB1, FAB2, and FAB3.

The only restriction in `Content` is that a `BomRef` is mandatory (1-1) in that a `Bom` for board material description must appear in the 2584 file.

IPC-2581/Content/BomNameRef=1

4.2 Logistic Descriptions

All requirements for the Logistic Descriptions **shall** be in accordance with IPC-2582. The only restriction that exists is that if the file will be used as a transfer of information outside of the domain that creates the file. In that instance, the `RoleRef` attribute of `Person` must exist and is no longer optional.

IPC-2581/LogisticHeader/Person@RoleRef=1

It is a requirement that the `Role` name is one of the 8 enumerated strings listed in IPC-2582 with a recommendation that if no other obvious name exists, the name SENDER should be used.

IPC-2581/LogisticHeader/Role@name=SENDER

It should be understood that the sender of the file may not actually have electronic means to add data or modify the existing XML schema instance. If a dialog occurs between the sender and receiver of the data, a verification should be made to establish file hierarchy and modification capability at either end.

4.3 File History Descriptions

All requirements for the History Descriptions are in accordance with IPC-2582. The restrictions are slightly different for the various fabrication levels and pertain to:

FAB1 has no restrictions and meets all requirements of IPC-2582.

FAB2 takes the `changeRecord` and makes it a mandatory requirement (1-n instead of 0-n).

FAB3 requires that `changeRecord` and the `Approval` element are a mandatory part of the instance file.

IPC-2581/HistoryRecord/ChangeRec=1-n
IPC-2581/HistoryRecord/ChangeRec/Approval=1-n

Figure 4-1 provides a case study of the HistoryRecord. The figure and subsequent paragraphs show the trend in communication between design at the OEM level and manufacturing.

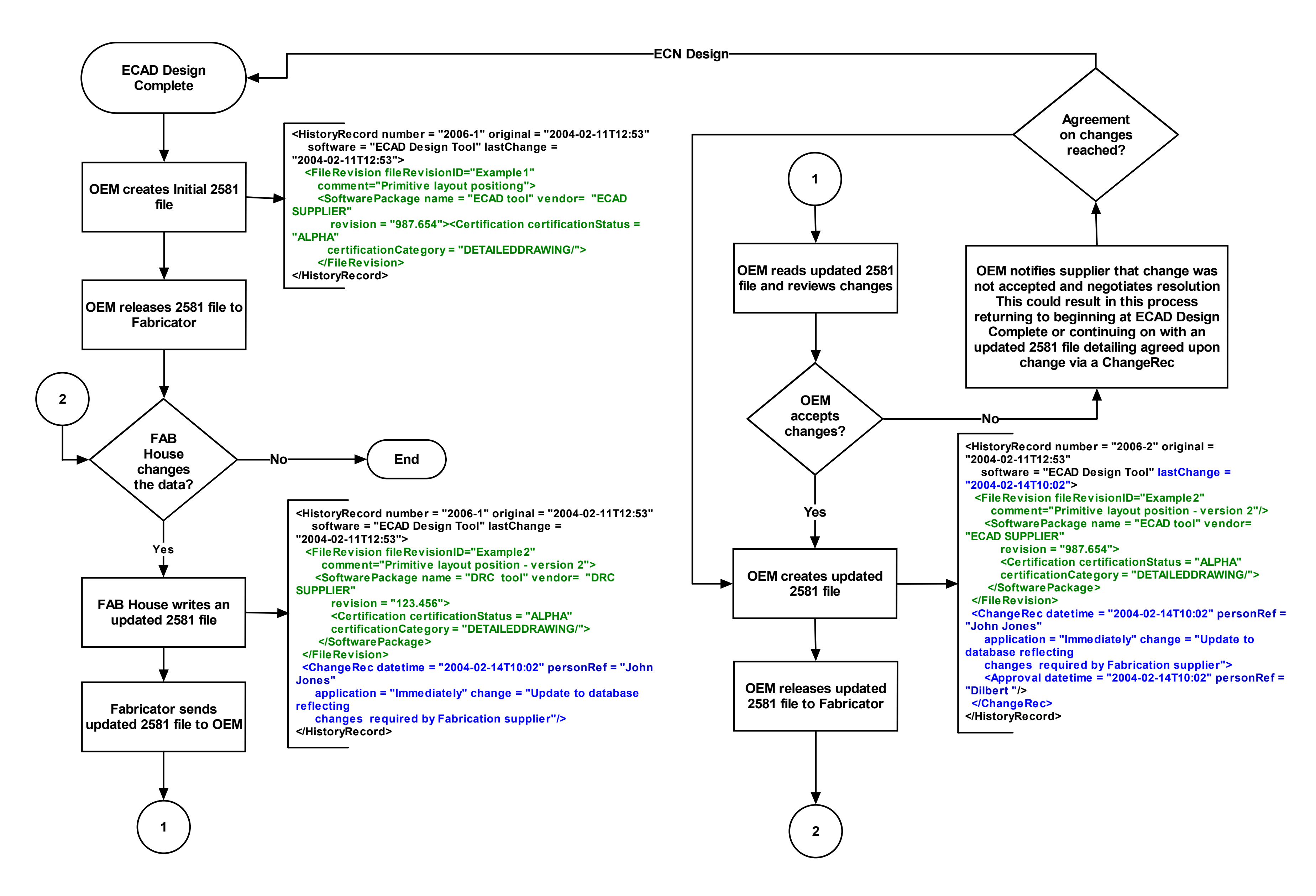


Figure 4-1 HistoryRecord Use Case

4.3.1 HistoryRecord Use Case – Initial Design Release

The EDA Design Tool creates the initial IPC-2581 file is with the LogisticHeader, HistoryRecord and the HistoryRecord child FileRevision elements.

4.3.1.1 Logistic Header

The LogisticHeader contains the contact information for the OEM personnel who have defined roles for the design project. There are many methods for getting contact information into the EDA tool for export to an IPC-2581 file. These methods will range from manual manipulation such as using a dynamic dialog box to automatically importing from a contacts.xml file or corporate database.

The `Role` name and `Person` name shall be unique names. The `Person` name may be an actual name, such as John Smith; title, such as Senior Designer; or department name, such as Purchasing Department.

Ideally, the ability to import all preferred supplier information from external sources will be available in order to include preferred suppliers in the `LogisticHeader` element. Below is a sample of the minimum data necessary for a complete `LogisticHeader` element with optional fields populated.

```
<LogisticHeader>
      <Role name = "OEM Account Manager" description = "OWNER"
            publicKey = "x3d8rf7ko90mKMC07" authority = "OEM purchasing
            agent"/>
      <Enterprise id = "OEM" name = "Design House" code="34567"
            codeType = "DUNS" address1 = "123 Avenue Street " city =
            "Bigcity" stateProvince = "PV" country = "US" postalCode =
            "99999-1111" phone = "888-555-1212" fax = "888-555-1212"
            email="purchasing@oem.com" url = "http://www.oem.com" />
      <Person name="Purchasing Manager" enterpriseRef ="OEM" title =
            "Senior Purchasing Manager" email =
            "purchasing.manager@oem.com" phone = "888-555-1212ext123"
            fax = "888-555-1212" roleRef = "OEM Account Manager "/>
<Logistic Header>
```

4.3.1.2 HistoryRecord

The `HistoryRecord` is the location of log type information for maintaining revision control of the IPC-2581 file for a design's life cycle. This does not mean that the entire history is present in any IPC-2581. It does give the OWNER a data record, which could be exported to a corporate database.

The EDA tool shall create a `HistoryRecord` for each IPC-2581 file by providing a means to enter the `HistoryRecord` number and the `FileRevision fileRevisionID`. This data could be entered by manual manipulation such as using a dynamic dialog box.

```
<HistoryRecord number = "2006-1" original = "2004-02-11T12:53"
       software = "ECAD Design Tool" lastChange = "2004-02-11T12:53">
      <FileRevision fileRevisionID="12345ENG-0"
             comment="Primitive layout position">
             <SoftwarePackage name = "ECAD tool" vendor= "ECAD
                  SUPPLIER"
                  revision = "987.654">
                  <Certification certificationStatus = "ALPHA"
                         certificationCategory = "DETAILEDDRAWING/">
```

```
        </SoftwarePackage>
    </FileRevision>
</HistoryRecord>
```

4.3.2 Supply Chain Modifications

A modification is added to the initial IPC-2581 file by a member of the Supply Chain. This modification can be as simple as adding a test coupon or panelizing the board to finding problems with the design and requiring design modification in order to produce a finish board.

4.3.2.1 LogisticHeader update

In order to add the `ChangeRec` to the `HistoryRecord`, the Supply Chain may need to update the `LogisticHeader` with additional information to provide the `Role`, `Enterprise` and `Person` data for the Supply Chain.

The supplier **shall not** modify the information associated with any Enterprise id other then their own. Updating the `LogisticHeader` shall create a `ChangeRec` even if no other data was modified. This will provide the means for the OEM to update their contacts information.

There are many methods for getting this information into the file that range from manual manipulation to importing a contacts.xml. Below is a sample of the contacts.xml file.

```
<LogisticHeader>
    <Enterprise id = "OEM" name = "Design House" code="34567"
        codeType = "DUNS" address1 = "123 Avenue Street " city =
        "Bigcity" stateProvince = "PV" country = "US" postalCode =
        "99999-1111" phone = "888-555-1212" fax = "888-555-1212"
        email="purchasing@oem.com" url = "http://www.oem.com" />
    <Role name = "OEM Account Manager" description = "OWNER"
        publicKey = "x3d8rf7ko90mKMC07" authority = "OEM purchasing
        agent"/>
    <Person name="Purchasing Manager" enterpriseRef ="OEM" title =
        "Senior Purchasing Manager" email =
        "purchasing.manager@oem.com" phone = "888-555-1212ext123"
        fax = "888-555-1212" roleRef = "OEM Account Manager "/>
    <Enterprise id = "Fab" name = "Board Shop" code="23456" codeType
        = "DUNS" address1 = "123 Street Avenue" city = "Mytown"
        stateProvince = "ST" country = "US" postalCode = "00000-
        1111" phone = "800-555-1212" fax = "800-555-1212"
        email="support@boardshop.com" url =
        "http://www.boardshop.com" />
    <Role name = "Supply Chain Customer Account Manager" description
        = "CUSTOMERSERVICE" publicKey = "x6d8rf7xd90mJHR13"
        authority = "Feed back to OEM"/>
    <Role name = "FAB Project Lead Engineer" description = "ENGINEER"
        publicKey = "x444rf7xd90mJHR13" authority = "FAB Lead
        Engineer"/>
    <Person name="Account Manager" enterpriseRef ="Fab" title =
        "Senior Global Account Manager" email =
        "customer.service@boardshop.com" phone = "800-555-
        1212ext123" fax = "800-555-1212" roleRef = "Supply Chain
        Customer Account Manager "/>
    <Person name="Project Engineer" enterpriseRef ="Fab" title =
        "Manager, Fabrication" email =
        "project.engineer@boardshop.com" phone = "800-555-
```

```
            1212ext456" fax = "800-555-1212" roleRef = " FAB Project
            Lead Engineer "/>
      <Logistic Header>
```

4.3.2.2 HistoryRecord update

The `HistoryRecord` parent **shall** remain unchanged by the Supply Chain's software. It is identified in the example by the use of underlined text. The Supply Chain's software uses the `FileRevision` to identify the software used to create the updated IPC-2581 file.

```
<HistoryRecord number = "2006-1" original = "2004-02-11T12:53"
      software = "ECAD Design Tool" lastChange = "2004-02-11T12:53">
      <FileRevision fileRevisionID="12345ENG-0mod"
            comment="Primitive layout position – updated with
            manufacturing requirements">
            <SoftwarePackage name = "DRC tool" vendor= "DRC SUPPLIER"
                  revision = "123.456">
                  <Certification certificationStatus = "ALPHA"
                        certificationCategory = "DETAILEDDRAWING/">
            </SoftwarePackage>
      </FileRevision>
      <ChangeRec datetime = "2004-02-14T10:02" personRef = "Supply
            Chain Engineer"
            application = "Immediately" change = "Update to database
            reflecting
            changes required by fabrication process."/>
</HistoryRecord>
```

4.3.3 OEM Reviews Modifications

4.3.3.1 HistoryRecord update

The OEM and their supply chain can use the `fileRevisionID` to match IPC-2581 files to their predecessors. Maintaining consistency in the `fileRevisionID` field will facilitate the ability to reuse items during the design's lifecycle.

```
<HistoryRecord number = "2006-2" original = "2004-02-11T12:53"
      software = "ECAD Design Tool" lastChange = "2004-02-14T10:02">
      <FileRevision fileRevisionID="12345ENG-1
            comment="Primitive layout position - version 2"/>
            <SoftwarePackage name = "ECAD tool" vendor= "ECAD SUPPLIER"
                  revision = "987.654">
                  <Certification certificationStatus = "ALPHA"
                        certificationCategory = "DETAILEDDRAWING/">
            </SoftwarePackage>
      </FileRevision>
      <ChangeRec datetime = "2004-02-14T10:02" personRef = "John Jones"
            application = "Immediately" change = "Update to database
            reflecting
            changes required by Fabrication supplier">
            <Approval datetime = "2004-02-14T10:02" personRef =
                  "Dilbert "/>
      </ChangeRec>
</HistoryRecord>
```

4.4 BOM (Board Fabrication Materials)

The BOM layer requirements **shall** be in accordance with IPC-2588. The following restrictions apply:

Bom/BomItem@category=MATERIAL

This is a mandatory requirement for FAB1, FAB2, and FAB3. Table 4-1 shows the `Bom` restrictions for board fabrication.

Table 4-1 Bom restrictions

Content/FunctionMode	FunctionModeType	@mode=FABRICATION @level=1	@mode=FABRICATION @level=2	@mode=FABRICATION @level=3
Bom/BomItem	BomItemType	@category=MATERIAL	@category=MATERIAL	@category=MATERIAL
Bom/BomItem/RefDes.	RefDesType	Per Table 4-2	Per Table 4-2	Per Table 4-2
Bom/BomItem/RefDes/Tuning	TuningType	0	0	0
Bom/BomItem/RefDes/ Firmware	FirmwareType	0	0	0
Bom/BomItem/RefDes/ Firmware/File	FileType	0	0	0
Bom/BomItem/RefDes/ Firmware/CachedFirmware	CachedFirmwareType	0	0	0
Bom/BomItem/RefDes/ Firmware/FirmwareRef	FirmwareRefType	0	0	0
Bom/BomItem/Characteristics	CharacteristicsType	@category=MATERIAL	@category=MATERIAL	@category=MATERIAL
Bom/BomItem/Characteristics/ Measured	MeasuredType	2582	1-n	1-n
Bom/BomItem/Characteristics/ Ranged	RangedType	2582	2582	1-n

When reference designators are required, as indicated for `BomItem`, the `RefDes` **shall** be in accordance with Table 4-2. Since the `RefDes` element is normally restricted to electronic components, this table has been constructed as a recommended methodology for defining different materials within the `Bom`. `RefDes` has a 1-n cardinality requirement. This is still appropriate for FAB1, FAB2, and FAB3. When the `RefDes` element is instanced, the attribute name **shall** be in accordance with Table 4-2.

IPC-2581/Bom/BomItem/RefDes@name=Table4-2

Table 4-2 Recommended reference designators for printed board material

Material type	Reference designator	Comments
Legend ink	LEG	
Soldermask	SDM	
Conductor	CND	
Dielectric base material	DBM	
Dielectric core	DIC	
Dielectric prepreg	DPP	
Dielectric adhesive	DIA	
Solder bump	SBM	
Hole fill material	HFM	
Resistive material	ERM	
Capacitive material	ECM	
Other	OTH	

Additional restrictions for `BomItem` are that the `Category` attribute **shall** be listed as MATERIAL.

IPC-2581/Bom/BomItem@category=MATERIAL

The `Characteristic` element also has some restrictions that pertain to FAB2 and FAB3. These relate to the occurrence of the `Measured` and `Ranged` elements which become mandatory in certain applications.

IPC-2581/Bom/BomItem/Characteristic@category=MATERIAL (same as BomItem)
IPC-2581/Bom/BomItem/Characteristic/Measured=1 (for FAB2 and FAB3)
IPC-2581/Bom/BomItem/Characteristic/Ranged=1 (for FAB3)

4.5 AVL (Board Material Suppliers)

The `AVL` requirements **shall** be in accordance with IPC-2588. The following restrictions apply and are detailed in Table 4-3:

Avl/AvlHeader@modRef=FABRICATION

This is an optional requirement for FAB2, and FAB3.

Table 4-3 Avl restrictions

Avl/AvlHeader	AvlHeaderType	@modRef=FABRICATION	@modRef=FABRICATION	@modRef=FABRICATION
Avl/AvlItem	AvlItemType	1-1	1-1	1-1
Avl/AvlItem/AvlVmpn	AvlVmpnType	@qualified=FALSE @chosen=FALSE	@qualified=FALSE or TRUE @chosen=FALSE or TRUE	@qualified=FALSE or TRUE @chosen=FALSE or TRUE
Avl/AvlItem/AvlVmpn/AvlMpn	AvlMpnType	0-1	0-1	0-1
Avl/AvlItem/AvlVmpn/AvlVendor	AvlVendorType	0-1	0-1	0-1

4.6 Documentation Layers

The documentation layer requirements **shall** be in accordance with IPC-2583. The following restrictions apply:

Ecad/CadData/Layer@LayerFunction=DOCUMENTATION

Ecad/CadData/Layer@name=unique layer name recommended consistent with Step name

This is a mandatory requirement for FAB1, FAB2, and FAB3.

4.6.1 Documentation Layer Restrictions

The following functions shown in Table 4-4 are applicable when a documentation layer is identified (italicized=optional).

Table 4-4 Documentation layer restrictions

Content/Function Mode	FunctionMode Type	@mode=FABRICATION @level=1	@mode=FABRICATION @level=2	@mode=FABRICATION @level=3
Ecad/CadData/ Layer	LayerType	*@layerFunction=COURTYARD*	*@layerFunction=COURTYARD*	*@layerFunction=COURTYARD*
		@layerFunction=GRAPHIC	*@layerFunction=GRAPHIC*	*@layerFunction=GRAPHIC*
		@layerFunction=DRAWING	@layerFunction=DRAWING	@layerFunction=DRAWING
		@layerFunction=LANDPATTERN	*@layerFunction=LANDPATTERN*	*@layerFunction=LANDPATTERN*
		@layerFunction=COMPONENT_TOP	@layerFunction=COMPONENT_TOP	@layerFunction=COMPONENT_TOP
		@layerFunction=COMPONENT_BOTTOM	@layerFunction=COMPONENT_BOTTOM	@layerFunction=COMPONENT_BOTTOM
		@layerFunction=OTHER	*@layerFunction=OTHER*	*@layerFunction=OTHER*

To aid in the interpretation, Table 4-5 provides a reference illustration table of those restrictions shown in their XML path description in Table 4-4.

Table 4-5 General descriptions of documentation layer functions

@layerFunction	FAB1	FAB2	FAB3	Remarks
COURTYARD	O	O	O	
GRAPHIC	O	O	O	
DRAWING	O	M	M	Used mostly for any form of documentation
LANDPATTERN	O	O	O	
COMPONENT_TOP	O	M	M	Only applies for assembly documentation
COMPONENT_BOTTOM	O	M	M	Only applies for assembly documentation
OTHER	O	O	O	

4.6.2 Reference to IPC-2614

The information in the following table highlights the documentation functions in accordance with IPC-2584 standard. This information **shall** be consistent with the documentation requirements of IPC-2614.

Figure 4-2 provides an illustration indicating approximate variation in the degree of mixture between electronic and hard copy documentation. Electronic documentation is considered non-intelligent (ready for printing hard copy), while Data is considered as being intelligent (ready for machine usage).

A	B	C
60 - 90 % Hard Copy	10 % - 60% Data	60% - 100% Data
10 - 40% Data	30 % - 80% Electronic Documentation	0% - 40 % Electronic Documentation
	10% - 60% Hard Copy	

Figure 4-2 Documentation Package Grade Requirements

Since that standard has three grades (A, B, C), plus three levels of complexity in each grade (1, 2, 3), a correlation should be established between the particular grade levels and the data documentation in an IPC-2584 file. (See Table 4-6)

Table 4-6 Relationship to documentation standard

Complexity/Grade	A	B	C
1	N/A	FAB1, FAB2	FAB1, FAB2
2	N/A	FAB1, FAB2, FAB3	FAB1, FAB2, FAB3
3	N/A	FAB2, FAB3	FAB2, FAB3

Grade B will fail the automated use case validation and needs to be manually validated. The goal is to strive for Grade C documentation when using the 2581 to accommodate a 60-100% data transfer.

4.6.3 Step Usage

The `Step` element is used several times when `Layer` is used for documentation. Each `Step` has a `step name`. The recommendation is that the `Step name` assigned to the `Step` is unique and is similar to the `name` attribute assigned for `layer`. The `LayerFunction` shall be DOCUMENTATION types. See Table 4-4.

4.6.3.1 Step

There may be one to many "`Step`"s in any 2581 file. Each `Step` has a unique name, which may be anything but is recommended to be an identifiable subset of the `Step` and should be in accordance with the attribute `Step/name`.

It should be noted that some "`Step`"s for documentation take advantage of previously defined "`Step`"s (i.e. taking a board `step` and an assembly `step` to make an assembly drawing. This would use the `StepRepeat` element to combine previously defined "`Step`"s by placing the graphical images on a drawing format.

Each `Step` requires a mandatory definition for `Datum` and `Profile`. All graphical information **shall** be provided as a `LayerFeature`.

When `LayerFeature` defines the graphical information using the various "`Set`"s, it **shall** be associated with the specific layer as identified by the layer name. This is accomplished through the mandatory `layerRef` associated with the `LayerFeature` of any `Step` within any 2581 file.

Step/LayerFeature@layerRef=Layer@name (unique user assigned)

4.6.4 Set

All documentation requirements shown in Table 3-1 **shall** be pre-defined in the user dictionary section of the file and will be instanced through the path:

Ecad/CadData/Step/LayerFeature/Set/Features

When documentation features are instanced at the time the feature is described, the `lineDescGroup` associated with the specific feature (Line, Arc, Polyline, Outline) **shall** take precedence and the `lineDescGroup` of `Set` **shall** be 0.

4.7 Design for eXcellence (Dfx) Analysis

All characteristics for `DfxMeasurement` **shall** be in accordance with IPC-2583. When Dfx analysis is required per the details in Table 3-1, the `DfxMeasurementList` **shall** restrict the category to BOARDFAB.

Ecad/CadData/Step/DfxMeasurementList@category=BOARDFAB

This is a mandatory requirement for FAB2 and FAB3.

4.7.1 DfxMeasurement

When DfxMeasurement characteristics are instanced at the time the feature is described, the lineDescGroup associated with the specific feature (Line, Arc, Polyline, Outline) **shall** take precedence and the lineDescGroup of Set **shall** be 0.

4.8 Miscellaneous Image Layers

Miscellaneous image layers are used primarily to capture and transfer graphical descriptions that do not necessarily belong in any of the specific categories of the CadData descriptions.

This layer's requirements **shall** be in accordance with IPC-2583. The following restrictions apply:

Ecad/CadData//Layer@layerFunction=OTHER

This is an optional requirement for FAB2 and FAB3.

4.8.1 Step usage

The Step element is used several times when Layer is used for miscellaneous layers. Each Step has a Step name. The recommendation is that the Step name assigned to the Step is unique and the name is similar to the layerFunction attribute assigned for layer. The LayerFunction shall be OTHER.

It is recommended that the information be included in the dictionary as graphical images, defined in the User or Standard dictionary and called out as needed.

4.8.1.1 Step

There may be one to many "Step"s in any 2581 file. Each Step has a unique name, which may be anything but is recommended to be an identifiable subset of the Step and should be in accordance with the attribute Step name.

Each Step requires a mandatory definition for Datum and Profile. See Table 4-7 for miscellaneous layer restrictions. All graphical information **shall** be provided as a LayerFeature.

Table 4-7 Miscellaneous layer restrictions

Content/FunctionMode	@mode=FABRICATION @level=1	@mode=FABRICATION @level=2	@mode=FABRICATION @level=3
Ecad/CadData/Layer	*@LayerFunction OTHER*	*@LayerFunction OTHER*	*@LayerFunction OTHER*

italicized=optional

4.9 Packages and Land Patterns

When Packages are required to define component dimensions, which is only as optional for level FAB3, the characteristics for Step **shall** define the instances of the package descriptions. When this occurs, the Layer PROCESS **shall** indicate ASSEMBLY.

Ecad/CadData/Layer@layerFunction=ASSEMBLY

This is an optional requirement only for FAB3.

Most packages are described in accordance with the Step Package function. The appropriate name of the Package type **shall** be in accordance with the IPC-2581/2587 e.g., BARE_DIE, FLIPCHIP, CHIP, OTHER, etc.

The name convention for Package type should be in accordance with Annex A of IPC-2581.

Ecad/CadData/Step/Package@name=per Annex A of IPC-2581
Ecad/CadData/Step/Package@type=per Package TypeType IPC-2586

4.9.1 Step Usage for Component Packages and Land Patterns

The Step element is used several times when Layer is used for Package layer descriptions. Each Step has a Step name. The recommendation is that the Step name is unique and is similar to the name and LayerFunction attribute assigned for Layer i.e., recommended step details coincide with; LayerFunction = ASSEMBLY.

4.9.1.1 Step

There may be one to many "Step"s in any 2581 file. Each Step has a unique name, which may be anything but is recommended to be a similar subset of the Step name used for component package descriptions and should be in accordance with the attribute step name.

Each Step requires a mandatory definition for Datum and Profile. All graphical information **shall** be provided as a LayerFeature.

4.9.2 Land Pattern Details

The LandPattern is an optional (0-1) child element of Package. As such, it inherits all of the restrictions of Package as stated in the previous paragraphs and defines the appropriate Pad(s) and Target(s) needed to correlate the board surface copper to the characteristics of the Package being described. Three additional restrictions are required and those are the characteristics of the Pin(s) defined as a part of the Package. These attributes deal with electricalType and mountType and are enumerated strings. In their use in this application, the appropriate name **shall** be assigned as well as the pinType.

These requirements are in accordance with IPC-2581 and IPC-2587.

Ecad/CadData/Step/Package/Pin@type=THRU | SURFACE
Ecad/CadData/Step/Package/Pin@electricalType=ELECTRICAL | MECHANICAL | UNDEFINED
Ecad/CadData/Step/Package/Pin@mountType=per IPC-2587

CAD systems should either use through hole or surface mounting techniques for component attachment.

4.10 Solder Mask and Legend Layers

Any descriptions for solder mask and legend **shall** be in accordance with IPC-2581 with the restrictions shown in the following paragraphs:

4.10.1 Solder Mask Details

The Layer descriptions for solder mask **shall** restrict the layerFunction to the enumerated string SOLDERMASK. This is an attribute of the Layer element and includes a restriction to the side where the solder mask is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding CadData/Step shall be used to define board, board panel, or coupon characteristics.

Ecad/CadData/Layer@layerFunction=SOLDERMASK
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

4.10.2 Legend details

The Layer descriptions for legend **shall** restrict the layerFunction to the enumerated string LEGEND. This is an attribute of the Layer element and includes a restriction to the side where the legend is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding CadData/Step **shall** be used to define board, board panel, or coupon characteristics.

Ecad/CadData/Layer@layerFunction=LEGEND
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

The source for legend information is mostly derived from the Silkscreen element of Package for the components that are placed on the appropriate board side. Other legend Information, such as logos, UL status etc may be added to the final image defined under the Step/LayerFeature/Set/Features hierarchy.

In FABRICATION or ASSEMBLY modes the IPC-2581 elements shall present an explicit and unambiguous image of the layers to be produced. Therefore the FABRICATION or ASSEMBLY elements take precedence, when they exist. The legend layer image considered for production will be the single Step/LayerFeature/Set/Features for the appropriate legend.

All legend descriptions contained in the final Step/LayerFeature/Set/Features elements from the Silkscreen element of Package, or from other sources, **shall** be consolidated before the 2581 file is generated.

4.10.3 Step Usage for Solder Mask and Legend Layers

All layers representing data that ends up forming part of the Board **shall** be part of the Step whose purpose is defined using the enumerated string BOARD. Since legend and solder mask are inseparable from the board after fabrication then the legend and solder mask layers for the top and bottom sides (and inner layers, if defined, for special applications) of the board shall be included in the BOARD step.

Additional solder mask and legend layers may be included in a Step used to define BOARDPANEL, ASSEMBLYPALLET, or COUPON if these entities require special legend markings or solder mask descriptions or clearances.

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example; if the Layer Name for the top legend layer is Legend_Top then the step whose use is assigned as BOARD shall have a Step/LayerFeature element whose LayerRef is set to the qualified name “Legend_Top”.

4.11 Drilling and Routing (Tooling) Layers

Any descriptions for drilling and routing information **shall** be in accordance with IPC-2581 with the restrictions shown in the following paragraphs:

4.11.1 Drilling Details

The Layer descriptions for drilling **shall** restrict the layerFunction to the enumerated string DRILL. This is an attribute of the Layer element and includes a restriction to the side where the drilling is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding CadData/Step **shall** be used to define board, board panel, or coupon characteristics.

Ecad/CadData/Layer@layerFunction=DRILL
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL | ALL

4.11.2 Routing Details

The Layer descriptions for routing **shall** restrict the layerFunction to the enumerated string ROUTE. This is an attribute of the Layer element and includes a restriction to the side where the routing is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding CadData/Step shall define the “Step” purpose using the enumerated string BOARD.

Ecad/CadData/Layer@layerFunction=ROUTE
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL | ALL
Ecad/CadData/Step@purpose=BOARD

4.11.3 Step Usage for Drilling and Routing

All layers representing data that ends up forming part of the Board **shall** be part of the Step that is used to define BOARD characteristics. Since drilling (the actual physical drilled hole – absence of material +

barrel plating for plated holes and just absence of material for non plated holes) forms part of the final delivered board then data for all drill layers (for through holes as well as for all types of vias) shall be part of the step used to define the board, board panel, or coupon. Similarly the routing forms the outline of the final delivered BOARD and therefore all board route layers (usually a single one) shall belong to the step used for these descriptions.

Additional drilling and routing layers may be included in the Assembly array, Coupon or Panel steps if these entities require special mounting or tooling holes and for the routing layers forming the outline of these steps.

Layers that pertain to the BOARD step **shall** define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example – if the Layer Name for the through hole layer is Drill then the single Step whose Step purpose is assigned as BOARD shall have a Step/LayerFeature element whose LayerRef is set to the qualified name "Drill".

4.11.3.1 Additional Step Rerstrictions

Within a LayerFeature/Set information describing specific characteristics of drilling or routing aspects, the Pad element may be instanced (0-n). When Pad is instanced, the padUsage attribute of Set **shall** be restricted to either TOE | VIA | TOOLING_HOLE | NONE.

Ecad/CadData/Step/LayerFeature/Set@padUsage= TOE | VIA | TOOLING_HOLE | NONE

A 2581 file may also contain Step elements used to define TOOLING characteristics. This condition may occur where the step is a possible container for additional fixture information, such as electrical test fixtures. However drilled holes or routing information forming part of the CAD data **shall** always be included in LayerFeature/Set/Features belonging to the BOARD descriptions for any specific board. If a need is identified to describe use cases for fixtures that information should be contained in a TOOLING step.

4.12 Net List

When electrical connectivity information is required, which is optional for level FAB2 and mandatory for FAB3, the characteristics for the `Step` **shall** define the `PhysNetGroup` instances of the electrical descriptions. All requirements of IPC-2587 (IPC-2581) prevail. When this occurs, the physical net list represents all required information and does not require the component and package descriptions. The information thus defines the interconnectivity of the conductive pattern without reference to component pin or reference designation.

The conductor layers that will be used for calculating connectivity shall be those fitting the restrictions written below:

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

When the information required in the 2581 file necessitates that description of electrical testing include the references to component pins the file **shall** include `LogicalNet` descriptions that define the components their pin numbers and the component reference designators (`refDes`). In order to maintain a cohesive file a step used to define TOOLING should be used in order to coordinate the physical to logical descriptions.

Ecad/CadData/Layer@layerFunction=PROBE
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

4.12.1 Step Usage for Net List

In most cases the BOARD step is used to describe the physical interconnectivity of the conductor (CONDFOIL | CONDFILM) (and the drill layers) layers. In multilayer fabrication there are times it is important to perform the electrical evaluations prior to the final lamination step. This is especially

important when an internal double sided core contains vias that will be buried in the final lamination step. The `layer` element includes a methodology that permits identification of these sequential fabrication functions under the `CadData` element `Stackup`.

It is important to maintain consistency in the naming and cross referencing of the physical net information in conjunction with the board construction information. The `StackupGroup` element provides this feature that permits combining several layer under the element StackupLayer and provides an appropriate name that can be referenced in the final multilayer Board product. These features are especially useful for producing HDI boards which fabricate a core of several layers and then sequentially add micro via layers on the top and bottom of the stackup.

The use of multiple steps can manage the data consistency through the combination of physical and electrical descriptions related to the fabrication of sequential multilayer Board construction.

Ecad/CadData/Stackup/StackupGroup@name=unique identifier
Ecad/CadData/Stackup/StackupGroup/StackupLayer/@layerOrGroupRef=unique identifier
Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM|

Ecad/CadData/Layer@layerFunction=PROBE
Ecad/CadData/Layer@side=TOP | BOTTOM

4.13 Outer Conductive Layers

Any descriptions for the outer conductive layers **shall** be in accordance with IPC-2581 with the restrictions shown in the following paragraphs.

4.13.1 Outer Conductive Layer Details

All layers representing data that ends up forming part of the Board **shall** be part of the Step used to define the BOARD. The outer conductive characteristics are a mandatory requirement of FAB1, FAB2, and FAB3.

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM

4.13.2 Step Usage for Outer Conductive Layers

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example; if the Layer Name for the single top conductive layer is “Top” then the Step used to define the BOARD shall have a Step/LayerFeature element whose LayerRef is set to the qualified name “Top”.

Additional outer conductive layers may also in many cases be included in the assembly pallet, coupon or board panel steps as these entities require conductive elements such as thieving features, venting feature or fiducials to appear.

4.14 Inner Conductive Layers

Any descriptions for the inner conductive layers **shall** be in accordance with IPC-2581 with the restrictions shown in the following paragraphs.

4.14.1 Inner Conductive Layer Details

All layers representing data that ends up forming part of the Board **shall** be part of the Step used to define the BOARD. The inner conductive layer characteristics are a mandatory requirement of FAB1, FAB2, and FAB3.

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=INTERNAL

4.14.2 Step Usage for Inner Conductive Layers

Layers that pertain to the BOARD step **shall** define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example; if the Layer Name for the top most inner conductive layer is Layer2 then the Step whose Step is used to define BOARD shall have a Step/LayerFeature element whose `LayerRef` is set to the qualified name “Layer2”.

Additional inner conductive layers may also in many cases be included in the assembly pallet, coupon or board panel steps as these entities require conductive elements such as thieving features, venting feature or fiducials to appear.

Another example intended to clarify step usage would be the description of a ten (10) layer board. The board has eight (8) inner layers. Under the assumption that all layers are functional then in the step used to define the BOARD there will be eight distinct `LayerFeature` elements pointing to the named eight layers of this boards’ `Layer` element. Namely if the first inner layer from the top is called “signal2” and the second is called “ground3n” then there will be eight `LayerFeature` elements with the first two being:

StepList/Step/LayerFeature@layerNameRef = “signal2” ; and
StepList/Step/LayerFeature@layerNameRef = “ground3n”

respectively and so forth until all eight inner layers are covered. In FAB and ASSEMBLY modes (also TEST when TEST mode is covered) there shall be a Step that is used to define the BOARD and the layer images to be manufactured are solely represented by the respective `Step/LayerFeature` elements for which the `Step/LayerFeature`@layerNameRef elements point at those layers.

4.15 Board Construction

Any descriptions for the board construction layers **shall** be in accordance with IPC-2581 with the restrictions shown in the following paragraphs.

4.15.1 Board Construction Details

All layers representing data that ends up forming part of the Board **shall** be part of the Step(s) that have a purpose which defines the characteristics of a printed board, board panel, or coupon. The board construction characteristics are a mandatory requirement of FAB1, FAB2, and FAB3. The construction includes the stackup of the layers for the board and defines the order in which the conductive and non conductive materials are to be combined. The relationship of the naming conditions and the order in which the layers are identified is significant. Material properties are defined by the `layerFunction` attribute. Some examples are:

Ecad/CadData/Layer@layerFunction=CONDFOIL
Ecad/CadData/Layer@layerFunction=DIELPREG
Ecad/CadData/Layer@layerFunction=DIELCORE
Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM

Ecad/CadData/Layer@side=TOP
Ecad/CadData/Layer@side=INTERNAL
Ecad/CadData/Layer@side=BOTTOM

4.15.2 Step Usage for Board Construction

Layers that pertain to the BOARD step **shall** define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. When there are no features in the step the `layerFunction` defines the characteristics of the material (thickness, finish, etc.). As an example; if the Layer for the first dielectric layer in the board construction is prepreg the `layerFunction` **shall** be DIELPREG and the name would be “Dielectric One”. If the delectric had cutouts in it to accommodate resin flow the cutouts would be defined in the BOARD step and have a Step/LayerFeature element whose `LayerRef` is set to the qualified name “Dielectric One”.

Additional construction layers may also in some cases be included in the assembly pallet, coupon or board panel steps as these entities may require additional features that can be described in the element structure. The concepts become relatively important for special cutouts, or manufacturing features that help to describe panels for boards such as rigid-flex combinations or assembly arrays that have configurations in the borders for equipment usage or testing.

4.15.2.1 Stackup Restrictions

When defining construction of a multilayer board, the `Stackup` element describes the overall thickness and where the material is measured. The restriction under Board construction would be the `whereMeasured` attribute of `Stackup` and **shall** identify across which characteristic the overall thickness is measured.

Ecad/CadData/Stackup@whereMeasured=LAMINATE | METAL | MASK

5 MODELING

The data files of the 2581 may be mapped to the information models. Information models are developed to ensure that complete mapping is capable between the information provided within the 2581 characteristics.

The correlation is provided in an analysis models shown in IPC-2589. All data activities are based on activity models as defined in IPC-2589. The activity models covered by CAD and CAM include the engineering, design, administrative, and fabrication and assembly characteristics. Each of these sections are intended to be detailed into various levels of activity much like layers of information needed to perform a particular manufacturing process.

Figure 5-1 shows the activity needed to develop board fabrication data.

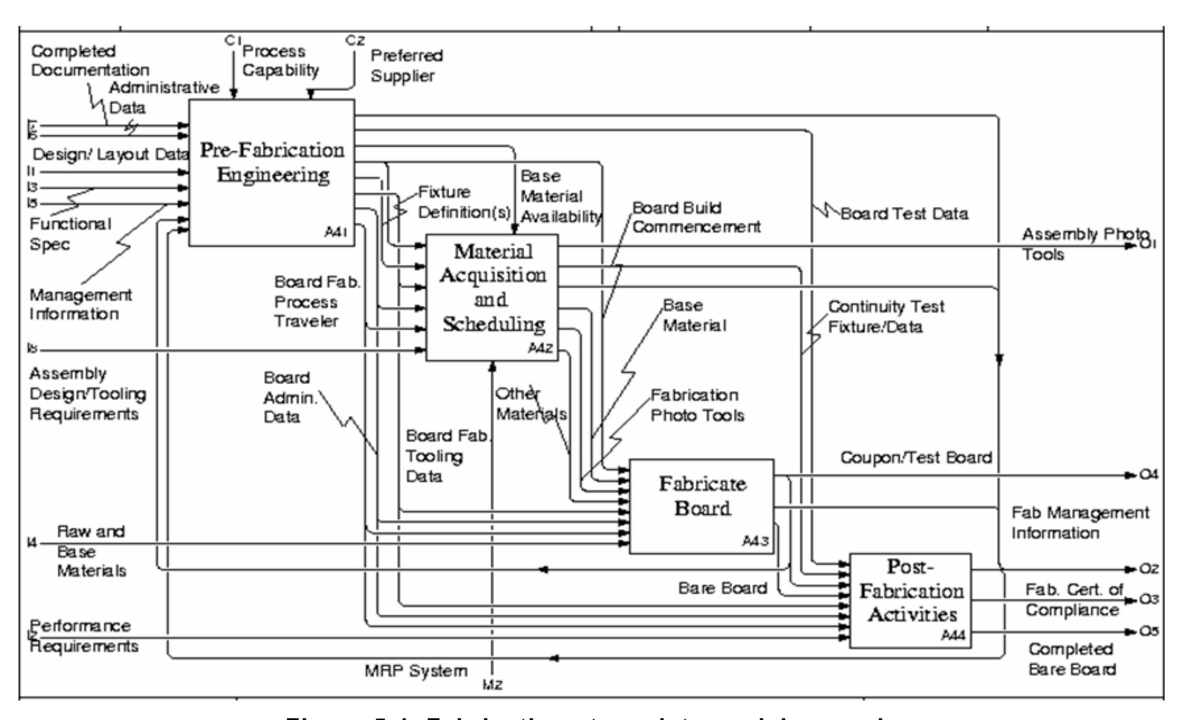


Figure 5-1 Fabrication steps data model example

5.1 Information Models

Information models are also helpful in understanding the requirements of the board fabrication section. Attribute information is correlated to the parameters of the 2581 as well as to the activity or analysis models used to describe board fabrication data.

UML (Universal Modeling Language) is used to develop the data design model as well as the analysis model. (see Figure 5-2).

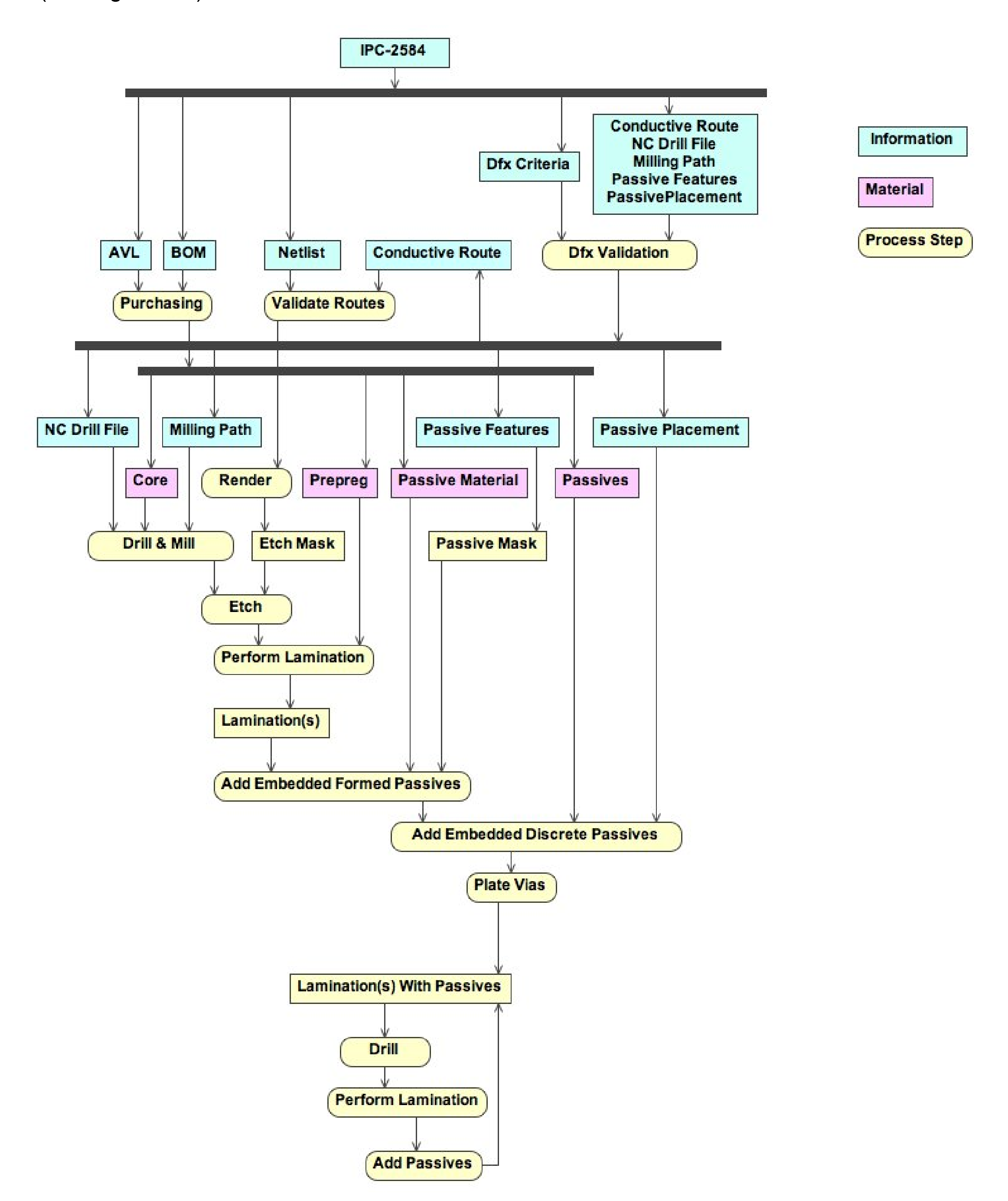


Figure 5-2 IPC-2584 UML Data Model

6 REPORT GENERATORS

Each of the sections of the 2581 format has various report generators that industry uses to provide the user with hard copy of the 2581 data file. Some of them are preferred based on industry preferences, others are mainly examples. The detailed report generators are described in each of the seven sections of the sectional documents i.e. IEC 2582 - 2588.

6.1 Hole Usage Report

```
HOLE SIZE USAGE
Hole Size Hole count Type Usage tooling
0.157 4 NPTH Tooling
0.020 40 PTH Electrical
0.035 65 PTH Electrical
0.041 120 PTH Electrical
0.125 8 NPTH Mechanical
Total 237
```

6.2 Pad Usage Report

```
PAD USAGE
X Y Count Pad
0.040 0.040 40 Fiducial
0.055 0.055 65 Component1
0.030 0.076 20 SOIC1
```

6.3 Conductor Usage Report

```
CONDUCTOR
USAGE
0.006
0.008
0.025
0.125
```

7 REFERENCE INFORMATION

The following sections define reference documents that are useful in clarifying the products or process of the industry or provide additional insight into the subject of data modeling or released information models.

7.1 IPC

IPC-2221 *Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies*

IPC-2615 *Printed Board Dimensions and Tolerances*

IPC-D-310 *Guidelines for Artwork Generation and Measurement Techniques for Printed Circuits*

IPC-D-325 *Documentation Requirements for Printed Boards, Assemblies and Support Drawings*

IPC-2611 *Generic Requirements for Electronic Product documentation*

7.2 American National Standards Institute

ANSI X3/TR-1-77 *American National Dictionary for Information Processing*

ANSI X3.12 *Subroutine Record Format Standardization*

ANSI Y14.5 *Dimensioning and Tolerancing for Engineering Drawing*

ANSI Y32.1 *Logic Diagram Standards*

ANSI Y32.16 *Electrical and Electrical Reference Designators*

ANSI Z210.1 *Metric Practice Guide (ASTM 380-72)*

7.3 Department of Defense

DoD-STD-100 *Engineering Drawings*

7.4 Electronic Industries Association

EDIF 4 0 0 *Electronic Data Interchange Format*

7.5 International Electrotechnical Commission (IEC)

IEC 61182-2 *Generic Requirements for Printed Board and printed Board Assembly XML Descriptions*

7.6 International Organization for Standards (ISO)

ISO STEP Documentation

AP210 *Electronic Printed Circuit Assembly: Drawings and Manufacturing*

AP211 *Electronic PC Assembly, Test Diagnostics & Remanufacture*

AP221 *Process Plant Functional Data & Schematic Representation*

APPENDIX A

PRINTED BOARD FABRICATION SCHEMA

IPC-2581
Content Elements in Accordance with IPC-2582
Logistic Header Elements in Accordance with IPC-2582
History Record Elements in Accordance with IPC-2582
BOM (Board Fabrication Materials) Elements in Accordance with IPC-2588
AVL (Board Material Suppliers) Elements in Accordance with IPC-2588
Miscellaneous Image Layers Elements in Accordance with IPC-2583
Documentation Layers Elements in Accordance with IPC-2583
Design for eXcellence (Dfx) Analysis Elements in Accordance with IPC-2583

IPC-2581/Ecad
IPC-2581/Ecad/CadHeader
IPC-2581/Ecad/CadHeader/Spec
IPC-2581/Ecad/CadHeader/Spec/Xform
IPC-2581/Ecad/CadHeader/Spec/Location
IPC-2581/Ecad/CadHeader/Spec/Outline
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadHeader/Spec/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadHeader/Spec/Outline/LineDesc
IPC-2581/Ecad/CadHeader/Spec/Outline/LineDescRef
IPC-2581/Ecad/CadHeader/Spec/Modification
IPC-2581/Ecad/CadHeader/SurfaceFinish
IPC-2581/Ecad/CadHeader/SurfaceFinish/FinishType
IPC-2581/Ecad/CadHeader/SurfaceFinish/FinishType/Color
IPC-2581/Ecad/CadHeader/SurfaceFinish/FinishType/ColorRef
IPC-2581/Ecad/CadHeader/ChangeRec
IPC-2581/Ecad/CadHeader/ChangeRec/Approval
IPC-2581/Ecad/CadData
IPC-2581/Ecad/CadData/Layer
IPC-2581/Ecad/CadData/Layer/Span
IPC-2581/Ecad/CadData/Layer/DrillTool
IPC-2581/Ecad/CadData/Stackup
IPC-2581/Ecad/CadData/Stackup/StackupGroup
IPC-2581/Ecad/CadData/Stackup/StackupGroup/StackupLayer
IPC-2581/Ecad/CadData/Stackup/StackupImpedance
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Xform
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Location
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Polyline
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Polyline/PolyBegin
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Polyline/PolyStepCurve
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Polyline/PolyStepSegment
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Polyline/LineDesc
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Polyline/LineDescRef
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Stackup/StackupImpedance/LayerRef
IPC-2581/Ecad/CadData/Step
IPC-2581/Ecad/CadData/Step/BooleanAttribute

IPC-2581/Ecad/CadData/Step/DoubleAttribute
IPC-2581/Ecad/CadData/Step/IntegerAttribute
IPC-2581/Ecad/CadData/Step/NonstandardAttribute
IPC-2581/Ecad/CadData/Step/OptionAttribute
IPC-2581/Ecad/CadData/Step/TextAttribute
IPC-2581/Ecad/CadData/Step/PadStack
IPC-2581/Ecad/CadData/Step/PadStack/LayerHole
IPC-2581/Ecad/CadData/Step/PadStack/LayerHole/Span
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Xform
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Location
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Butterfly
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Circle
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour
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IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour/Cutout
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Diamond
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Donut
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Ellipse
IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Hexagon
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IPC-2581/Ecad/CadData/Step/PadStack/LayerPad/Triangle
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Ellipse

IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Hexagon
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/RectCham
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Triangle
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark/Xform
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark/Location
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark/Butterfly
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark/Triangle
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/Xform
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/Circle
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/RectCham

IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/RectCorner
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GoodPanelMark/Butterfly
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/LocalFiducial/Xform
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Slot/Arc/LineDesc
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Slot/Outline/Polygon/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectCenter
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectCham
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectCorner
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/RectRound
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IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Outline/Polygon
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Outline/LineDesc
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Outline/LineDescRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Polyline

IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Polyline/PolyBegin
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Polyline/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Polyline/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Polyline/LineDesc
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Polyline/LineDescRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/Xform
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/BoundingBox
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/FontRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/Color
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/ColorRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/UserSpecial
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Features/UserPrimitiveRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/Color
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/ColorRef
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/LineDesc
IPC-2581/Ecad/CadData/Step/Route/LayerFeature/Set/LineDescRef
IPC-2581/Ecad/CadData/Step/Datum
IPC-2581/Ecad/CadData/Step/Profile
IPC-2581/Ecad/CadData/Step/Profile/Polygon
IPC-2581/Ecad/CadData/Step/Profile/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Profile/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Profile/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Profile/Cutout
IPC-2581/Ecad/CadData/Step/Profile/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Profile/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Profile/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/StepRepeat
IPC-2581/Ecad/CadData/Step/Package
IPC-2581/Ecad/CadData/Step/Package/Outline
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/Outline/LineDesc
IPC-2581/Ecad/CadData/Step/Package/Outline/LineDescRef
IPC-2581/Ecad/CadData/Step/Package/LandPattern
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Xform
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Location
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Butterfly
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Circle
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Cutout/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Donut
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Ellipse
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Hexagon
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IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Octagon
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Oval
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/RectCenter
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/RectCham
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/RectCorner
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/RectRound

IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Thermal
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/Triangle
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Pad/StandardPrimitiveRef
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Xform
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Location
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Butterfly
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Circle
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Polygon
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Cutout
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Contour/Cutout/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Oval
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/RectCenter
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/RectCham
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/RectCorner
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/RectRound
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Thermal
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/Triangle
IPC-2581/Ecad/CadData/Step/Package/LandPattern/Target/StandardPrimitiveRef
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Outline
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Outline/Polygon
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Outline/LineDesc
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Text/BoundingBox
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Text/FontRef
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Text/Color
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Text/ColorRef
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Cutout
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Cutout/PolyStepCurve
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Diamond
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Donut
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Ellipse

IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Hexagon
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Octagon
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IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/RectCham
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/RectCorner
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/RectRound
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Thermal
IPC-2581/Ecad/CadData/Step/Package/SilkScreen/Target/Triangle
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IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Outline/Polygon
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Outline/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Outline/LineDesc
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IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Butterfly
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Circle
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Polygon
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Cutout
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/Contour/Cutout/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/Package/AssemblyDrawing/Target/RectCham
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IPC-2581/Ecad/CadData/Step/Package/Pin/Location
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IPC-2581/Ecad/CadData/Step/Package/Pin/Outline/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/Package/Pin/Outline/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/Package/Pin/Outline/LineDesc

IPC-2581/Ecad/CadData/Step/Package/Pin/Outline/LineDescRef
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IPC-2581/Ecad/CadData/Step/Component/DoubleAttribute
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IPC-2581/Ecad/CadData/Step/Component/NonstandardAttribute
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IPC-2581/Ecad/CadData/Step/Component/TextAttribute
IPC-2581/Ecad/CadData/Step/Component/Xform
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IPC-2581/Ecad/CadData/Step/VplPackage/Outline/Polygon/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Contour/Polygon/PolyBegin
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IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Contour/Cutout
IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Contour/Cutout/PolyStepCurve
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IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Moire
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IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/RectCham
IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/RectCorner

IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/RectRound
IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Thermal
IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Triangle
IPC-2581/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/StandardPrimitiveRef
IPC-2581/Ecad/CadData/Step/LayerFeature
IPC-2581/Ecad/CadData/Step/LayerFeature/Set
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/DoubleAttribute
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/IntegerAttribute
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/NonstandardAttribute
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/OptionAttribute
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/TextAttribute
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Xform
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Location
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Butterfly
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Circle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Polygon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Diamond
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Donut
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Ellipse
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Hexagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Moire
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Octagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Oval
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/RectCenter
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/RectCham
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/RectCorner
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/RectRound
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/Triangle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Pad/StandardPrimitiveRef
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Xform
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Location
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Butterfly
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Circle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Polygon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Polygon/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Cutout
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Cutout/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Diamond
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Donut
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Ellipse
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Hexagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Moire
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Octagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Oval
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/RectCenter

IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/RectCham
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/RectCorner
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/RectRound
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Thermal
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Triangle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/StandardPrimitiveRef
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Xform
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Contour/Polygon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Diamond
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Donut
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Ellipse
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Octagon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/RectCham
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/RectRound
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GlobalFiducial/Triangle
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Xform
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Location
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Butterfly
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Circle
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyStepCurve
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Polygon/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Cutout
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Contour/Cutout/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Oval
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/RectCenter
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/RectCham
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/RectCorner
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/RectRound
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Thermal
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/Triangle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/GoodPanelMark/StandardPrimitiveRef

IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Xform
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Location
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Butterfly
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Circle
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Contour
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Contour/Polygon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/LocalFiducial/Contour/Polygon/PolyStepCurve
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Slot
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Circle
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Contour/Cutout
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Contour/Cutout/PolyBegin
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Contour/Cutout/PolyStepCurve

IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Contour/Cutout/PolyStepSegment
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Diamond
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Donut
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Ellipse
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Hexagon
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Octagon
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Oval
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/RectCenter
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/RectCham
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/RectCorner
IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/RectRound
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Line/LineDescRef
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IPC-2581/Ecad/CadData/Step/LayerFeature/Set/Features/Polyline/PolyStepCurve
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IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Outline/Polygon/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Outline/LineDescRef
IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Polyline

IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Polyline/PolyBegin
IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Polyline/PolyStepCurve
IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/Polyline/PolyStepSegment
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IPC-2581/Ecad/CadData/Step/DfxMeasurementList/DfxMeasurement/FeatureDescription/Location